SCIENCE

NEW YORK, MAY 1, 1891.

RECENT PROGRESS IN SOLAR PHYSICS AS BEARING UPON THE CAUSE OF THE ICE AGE.

AMONG the many hypotheses invoked to find an adequate cause for the glacial period, that of a time of diminution of the sun's emission of heat has had little consideration. Although apparently naming a cause adequate to the effect, it seemed too violent an assumption, and one opposed to generally accepted fact, that the supply of heat from the sun could vary to any material amount. The universal conception of the solar orb and its activities was that of extreme steadiness and uniformity of behavior, as being almost an emblem of immutable law. Any change or abatement in the sun's energy in supplying heat and light seemed as foreign to a proper notion of that body as would be a deviation from punctual rising and setting as laid down in the almanac.

Hence, in the presence of the brilliant and imposing astronomical theory of Dr. Croll, the more obvious hypothesis of solar variation lapsed out of sight. Of late, however, the former theory is becoming discredited by the growing clearness of evidence that the ice age was too recent to be accounted for thereby. The rates of recession of the Niagara gorge and of the falls of the Mississippi render it difficult to account for a continental glacier still existing seven thousand years ago, by an eccentricity of the earth's orbit which occurred fourteen times as far back in the past.

During the quarter-century since Dr. Croll's theory came into vogue, our knowledge of solar physics has been enormously developed and quite revolutionized. Possibilities and probabilities as to the variability of the sun's emission of heat are now well known, which then were not even matters of vague conjecture. Inspection of the structure and activities of the sun by means of the spectroscope has wholly changed the former conditions for reasoning about its variability.

The most conspicuous result of this spectroscopic inspection is our knowledge that the sun exhibits the most violently energetic activity all over its surface, far into its depths, and far outside of the photosphere. It continually generates and radiates into space almost inconceivable floods of light and heat. This is attended by intensely violent ebullition at the surface, in which vast streams of fluid matter are constantly flung aloft tens and hundreds of thousands of miles above the photosphere. The most titanic eruptions of earth, such as Krakatoa, are, when compared with those hourly occurring in the sun, far less than the dust-whirl of the street is to the tornado that wrecks a city.

I adduce this fact of violent ebullient activity in the sun as lending a presumption of more or less inequality in that activity. It gives the impression of contending forces arrayed against each other, necessarily disturbing equilibrium, and forbidding an equable and uniform emission of light and heat. Such inequality is markedly indicated by the known periodicity of the cyclonic sun-spots, and their attendant cosmic magnetic disturbances. There still lack results of actual observation to verify the fact of such fluctuation. The younger Angström of Sweden is understood to be now conducting delicate observations with this intent.

A vastly more extended area for observation and classification of facts relating to solar physics has been opened in the new department of stellar spectroscopy in which Dr. Norman Lockyer is the worker best known to the public. By the classification of the spectra of many hundreds of fixed stars and nebulæ, a series of grades of solar evolution have been approximately determined, beginning with suns incipiently gathering from diffused nebulous matter, and going on through successive stages of accumulation, concentration, intensifying heat, culmination, decline, and approaching extinction. All these stages are determined and classified by the peculiarities of their spectra. Dr. Lockyer is thus enabled to write approximately the history of a sun from its earliest genesis to its extinction as a luminary. Our own sun has been definitely assigned by the character of its spectrum to a class of stars of decreasing temperature, which have passed the culminating point of their activity, and are going on towards decline, like Procyon, Capella, and Arcturus. Aldebaran, Altair, and Alpha Cygni are examples of another class approaching their culmination, and increasing in brightness. Sirius is in a still earlier and more vaporous stage.

While the known violence of the sun's internal activity is suggestive of frequent transient variations in the amount of heat emitted, the above named long progressive changes are equally suggestive of vast secular oscillations in the course of the increase and decrease observed. It seems, indeed, quite impossible that those long-continued progresses of increase and subsequent decline in the heat and light of solar orbs should go on with absolute uniformity of gradation. All such processes of active change in nature are characterized by fluctuation, by alternating ebb and flow; and such a process as this would be the last to show an exception to the rule. It involves a continual balancing of mighty contending forces, forever swaying the resultant thermal condition up and down with varying divergence from an even grade of increase or decrease.

It is only in harmony with the universal laws of material activity — and it is nearly impossible to conceive it otherwise — that the heat of the sun, as it slowly diminishes through the ages, should at intervals make strong sweeps upwards or downwards, again recovering itself to its average grade of slow decline, rather than that it should progress in a uniform and imperceptible diminution. It thus seems in the highest degree probable that the sun is subject to considerable secular variations in its heat, such as might have caused the glacial period, as well as the just preceding age of arctic warmth.

As observed above, the enormous violence of the sun's internal movements, which is actually seen to exist, seems necessarily to involve fluctuation in its effects. Such opposing energies cannot uniformly so balance each other as to produce a uniform emission of light and heat. An enormous expenditure of force is going on with the progressive condensation of the vast orb. Volumes of heat and light inconceivably great are being every instant shot forth and dis-

tributed into boundless areas of space. All this is supplied by the contraction of the sun's bulk. It is in place now to specify some of the interacting and counteracting forces involved in this process of shrinkage of diameter and radiation of heat. We shall more clearly see causes of inevitable disturbance of equilibrium in the constantly varying energy of the different factors which play unequally against each other.

Every atom of the solar orb is being continually drawn towards its centre by the gravitation of the sun's own tremendous mass; but this tendency is resisted by the intense heat, which causes each particle to repel its neighbor, and so to prevent and delay that condensation to compact solidity which is to be the ultimate result. Heat must be parted with before the strenuous behest of gravity can be obeyed. Thus the process of contraction goes on with extreme slowness, only by means of, so to speak, the squeezing-out of immense volumes of heat from the whole mass. The result is an imperceptible contraction of bulk, leaving the sensible heat practically undiminished, although latent heat has been copiously expended. The heat thus continually released, and oozing from every molecule throughout the bulk of the mighty orb, finds escape from the interior to the surface by means of vast upboiling currents of superheated fluid which carry out the heat; in other words, by the process of convection.

Now observe the elements of variation as found in the interacting forces involved. The primary factor in this combination is the force of gravitation; but gravitation must increase inversely as the square of the sun's radius. As the bulk shrinks, gravity multiplies. When the sun had twice its present diameter, its particles drew together only one-fourth as hard as they do now. Here, then, is a steadily changing factor tending to disturb the uniformity of the heat emitted.

A second ever-changing factor is the area of the radiating surface of the photosphere. This varies, not inversely like gravitation, but directly as the square of the sun's radius. When the sun was twice its present diameter, the area of its photosphere was four times as extensive: in other words, the heat had four times as wide a gate to find escape through. This, again, tends to disturb uniformity in the emission of heat.

A third element of variation is to be found in molecular repulsion, which varies not only with the amount of sensible heat, which is possibly still rising as the sun grows denser, but it will also vary as the square of the decreasing distances between the crowding molecules. This influence is opposed to that of gravitation, and tends to prevent condensation. This varying quantity constitutes a third antagonist in the fray, as the war sways to and fro in the sun's interior.

A fourth factor is the slowly lessening distance from the sun's centre to its surface, which facilitates the transit of the outgoing currents conveying to the surface the superheated fluids of the contracting interior. As the sun shrinks, the path to the surface shortens directly as the radius, thus tending to increase the escape of heat.

But counteracting this is the increasing density of the sun's contents, which varies inversely as the cube of the radius; that is, as the shrinkage of bulk. The mass of the sun is now eight times as dense as when of twice its present diameter. This greatly increases the resistance to movement of internal currents, just as one hundred people in a hall of a given size will move about more than twice as easily as two hundred people in the same hall who crowd and jostle each other.

A sixth and perhaps very variable factor which powerfully retards the radiation of light and heat, is the enveloping atmosphere of the sun, estimated at several thousand miles in depth, and of considerable density. This atmosphere, like an enswathing blanket, arrests a large portion of the radiated heat. Now, the quantity of this atmosphere being assumed as constant, its depth will tend to vary inversely as the area, that is, as the square of the sun's diameter, and so the radiation of heat be hindered increasingly as the sun shrinks.

It is quite impossible, however, that the quantity of atmosphere outside of the photosphere should remain exactly constant. Large quantities are evidently carried down into the sun's interior by the plunging rush of the sun-spot vortices, no doubt to boil up again to the surface.

Added to the regular atmosphere are the red cumulus protuberances above the atmosphere, composed of more tenuous vapor forced out perhaps by electric repulsion. These must contribute to arrest the escape of heat, and are also variable in quantity.

This brings us to another probable element of a perturbing nature in its influence upon the escape of heat; that is, electrical repulsion. It is probably this which not only drives forth the red protuberances to such an enormous height, but which also shoots out the broad streamers of the sun's corona. The tails of comets are probably forced outwards by a similar repulsion from the sun.

As this force is habitually attendant upon molecular activity and the generation of heat, it must be subject to considerable fluctuation with the violent internal agitation of the orb. To all this fluctuation the earth's magnetism constantly responds, like a delicate galvanometer. How much more powerfully, then, must the sun's own atmosphere respond, dilating and bristling out with every rising wave of electrical agitation! Such dilatation of the atmosphere and its vast appendages cannot fail to diminish the radiation of heat, like a bird roughing its feathers in the cold.

Miss Agnes Clerke describes those stars in the same class as our sun as being more strongly electrified than the others, and hence likely to be more active in their fluctuations of repelling force.

Recent developments in chemical science promote belief in the existence of elementary forms of matter not yet actually observed. Certain peculiarities in the spectrum of the sun are thought to indicate that much of its matter is still in such elementary forms, owing to its intense heat. This increases the probability that great chemical processes are going on in the sun, which are attended with evolution of heat, and which thus contribute to the complexity of causes producing variation thereof.

Should we adopt the conjecture of Mr. Proctor and others, that the supply of heat in the sun is largely maintained by a bombardment of meteorites supposed to be densely swarming about it, we might find in this another element of variation. This is, however, hardly more than unsupported conjecture.

The foregoing enumeration of certain and probable factors in the sun's internal activity, as contributing to produce much variation in the resultant emission of heat and light, is necessarily but rude and imperfect; yet at least it serves to illustrate and lend probability to the hypothesis advocated in this essay. Some of the causes of fluctuation named seem most adapted to produce comparatively brief and transient inequalities of radiation, such as might easily be verified by long-extended instrumental measurements in elevated posi-

tions. It seems not unlikely that the greater part of the meteorological perturbations of our globe will be found closely connected with such transient inequalities in the sun's activity.

Some of the factors concerned seem, however, more adapted to produce secular oscillations in the sun's evolution of heat, extending through periods like the thousands of years probably occupied by the glacial age, and by the antecedent age of arctic warmth.

The one impossible thing would seem to be that the conflict of all those struggling and discordant forces should generate such an equalized and perfected balance in their resultant, that the sun's emission of light and heat should continue uniform and undisturbed from age to age; that it should not, indeed, from time to time be subject to very great fluctuations. In this view of the question, it seems not unreasonable to claim at least a place of high consideration for this hypothesis among other unverified hypotheses of the cause of the glacial period.

It may be claimed in favor of this hypothesis that it serves to account for the antecedent age of arctic warmth, as well as for the glacial age. Dr. Croll's hypothesis wholly failed in this respect. Nor, as it occurred not earlier than the pliocene, can it be attributed to conditions belonging to the carboniferous period.

As an objection to the solar hypothesis, it has been alleged that a diminution of solar heat would forbid the evaporation required to supply a precipitation of snow adequate to form glaciers. To this it may be replied that existing glaciers, like that of Greenland, are by no means supplied from the copious evaporation of the tropics, which is all precipitated in the neighboring latitudes. They are fed from the far lesser evaporation of the neighboring open seas, including the extremities of the Gulf and Kurasiwo currents. It is estimated that a general reduction of temperature of 18° to 20° F. over the earth's surface would produce the glacial period. Even with such a reduction in the sun's supply of heat, a large evaporation would continue, as well as air and ocean currents distributing the reduced warmth. The necessarily resulting changes would not involve a suspension of evaporation and precipitation, but rather a transfer of the areas of glaciation from the arctic to the temperate zone, such as actually took place in the glacial age.

SERENO E. BISHOP.

THE CULTIVATION OF THE SUGAR-BEET IN OHIO.

"FARMERS' BULLETIN No. 3" of the United States Department of Agriculture is an abridgment of a monograph on the sugar-beet, recently compiled by Professor H. W. Wiley, chemist of the department.

Judging from European experience, it seems probable that the culture of the sugar-beet in America will be most successful within the limits of a belt of about one hundred miles on each side of the summer isotherm of 70°; that is, a line marking an average temperature of 70° for the months of June, July, and August. In Ohio this line follows approximately the southern shore of Lake Erie, so that the northern third of the State is included within the belt named.

The summer temperature is not the only climatic question that must be considered, however; as, for instance, the mild winters of southern California permit the piling of the beets in immense heaps, requiring no protection, or, at most, but a slight covering of straw, and thus extending the working season throughout the winter; whereas in northern Ohio the beets would have to be pitted or housed in expensive cellars or silos. Again, the California winter gives a season of three or four months during which planting may be done, or three times as long as in northern Ohio.

The soil most favorable to the culture of sugar-beets is one that is easily worked, and is fertile enough to produce rapid growth. The moderately sandy soils, and especially the black sands of northern Ohio, will probably be found well adapted to beet-culture. The fertile bottom-lands of the farm occupied by the experiment station at Columbus produce large crops of beets. Stiff, heavy clays will not be found satisfactory, as a rule, unless thoroughly underdrained and brought up to a high state of fertility by previous manuring and the growth of clover.

The variety of beet is an important point, but a yet more important one is the care with which the seed has been selected. In France and Germany the percentage of sugar in the beet has been very greatly increased by improvements in the production of seed.

The manufacture of sugar from beets involves the use of very expensive apparatus, and requires great technical skill. In 113 German factories the mean capital invested in each factory is nearly two hundred thousand dollars; and the total expense of manufacture is nearly eight dollars per ton, counting the beets at a little less than five dollars per long ton. The experience of the Ohio Experiment Station is, that, on suitable soils, beets can be raised at this price with a very wide margin for profit.

The bulletin referred to contains illustrations of machinery used in beet-culture, and many other interesting items which cannot be condensed into a brief abstract. The station has received a few copies of this bulletin for distribution in Ohio, and will take pleasure in sending them free of all costs to all applicants, while the supply lasts. Address Experiment Station, Columbus, O.

NOTES AND NEWS.

AN exhibition of all the means of advertising will be held at the Palais des Beaux-Arts, Champ-de-Mars, Paris, from May 17 to Sept. 15.

— For a year past, the crater of Halemaumau, in the volcano of Kilauea, Hawaii, has been in a state of high activity, the lava frequently pouring out through ducts upon the main floor of Kilauea. On March 5 sinking began, attended with slight earthquakes, extending into the neighboring district of Kau. By the 8th the collapse was complete. The interior cone, with the adjacent fire-lakes, had sunk out of sight; and the entire area of Halemaumau, over half a mile in diameter, is now occupied by a pit estimated at five hundred feet in depth. It was just five years after the last and similar collapse. As then, no fire is now in sight. Some fissure has opened in the side of the main column of lava, and discharged the contents under ground. It is perhaps not a mere coincidence that on March 4 the mercury in Honolulu reached the lowest point on record, 48°. The extreme cold of March 10 in England will be noted in this connection. A full report of the condition of Kilauea is expected from Professor Brigham, who is now on the ground.

— The forthcoming May number of the *Review of Reviews* contains, under the title "Three Empire Builders," some timely character sketches. One deals with Sir Henry Parkes, prime minister of New South Wales, the father of Australian federation, and chairman of the great constitutional convention which has just concluded its labors at Melbourne. Another deals with Sir John Macdonald. The third sketch has the Hon. Cecil Rhodes for its subject, Mr. Rhodes being the gifted young Englishman who, a few years ago, went out as a consumptive student from Oxford to regain his health in Africa, and who has been conquering a new empire for Great Britain with Capetown as its capital. Among the special features of the May number will be found an article entitled "Workingmen's Clubs vs. The Bar-Room." "The Progress of the World," an editorial department of the *Review of Reviews*, contains in the May number a map of Australia showing the newly federated provinces, several maps showing the course of the new Nicaragua Canal, and various portraits.

— At a meeting of the trustees of the Johns Hopkins University, held April 6, 1891, the president of the university stated that a lady in New England had authorized him to offer the university the sum of five hundred dollars, to be bestowed in annual prizes during the next ten years, under the following conditions: the

prize shall be awarded for the best essay written by a graduate student upon some subject in historical or political science, ancient or modern, and submitted by him or for him to the academic council. The prize shall consist of a bronze replica of a likeness of Chief Justice Marshall, together with printed copies of his decisions (if they can be obtained). The prize shall be known as The John Marshall Prize of the Johns Hopkins University. To indicate the character of the work which the donor desires to encourage, she requests that three copies of the likeness be given as prizes for three essays to be selected by competent judges from the essays already published by recent members of the university. She desires that the further regulations for the bestowal of the prize shall be made by the president of the university, with the concurrence of the academic council. If, at the end of ten years, any balance shall remain unexpended, it shall be devoted by the trustees to the continuation of the prize, or to any other object that they may select.

— An expedition into southern and eastern Maryland has been organized, through the co-operation of the Johns Hopkins University, the United States Geological Survey, and the Maryland Agricultural College. The project has been approved by the governor and Board of Public Works of the State, and one or more steamers of the Maryland Oyster Navy will be detailed for the accommodation of the members of the expedition. The object of the expedition is to study the natural resources of the southern and eastern portions of the State. The heads of the Johns Hopkins University, the United States Geological Survey, and the State Agricultural College have designated the following persons as a board of control: Professor W. B. Clark of the Johns Hopkins University, chairman; Professor Milton Whitney of the State Agricultural College, secretary and treasurer; Mr. W. J. McGee of the United States Geological Survey. The expedition was to leave Baltimore April 23.

— Among the results already obtained from the oceanographic expedition of the "Pola," organized by the Academy of Sciences of Vienna, are the following, as we learn from *Nature* of April 16: The water of the central basin of the Mediterranean was found to be warmer, denser, and richer in dissolved salts, than the western basin. As regards the penetration of light into the sea, a white disk was visible only at a depth of 43 metres, but photographic plates were affected at a depth of 500 metres. Starting from the surface of the sea, the quantity of oxygen dissolved at first increases with the decrease of temperature, but then again decreases, so that at a depth of 3,000 metres the proportion is the same as that at the surface. In no case was any free carbonic acid found. The nitrogenous substances in solution vary in inverse proportion to the depth: that of ammonia varies but slightly, but is greater in the lower strata.

— The next annual meeting of the Royal Society of Canada will open in Montreal on Wednesday, May 27, 1891. The sessions usually last one week. It is anticipated that the meeting will be attended by many distinguished persons eminent in literature and science from Europe and the United States as well as from the Dominion of Canada. The ordinary sessions of the society will be held in the buildings of the McGill University, and the popular evening lectures will be delivered in the Queen's Hall on St. Catherine Street. The museums and art galleries, with the educational, industrial, and other institutions of the city, will be opened to visiting members and associates. Local excursions to places of interest in the neighborhood will be arranged for; and receptions, garden-parties, and entertainments of various kinds, will also be provided. To members and associates attending the meeting, the Intercolonial Railway of Canada will issue return tickets over its system at a single fare. The Grand Trunk and the Canadian Pacific Railways, together with their connecting railways in the United States, will issue similar tickets at a fare and a third for the double journey. The committee are engaged in the preparation of a handbook, for gratuitous circulation among intending visitors, which will include an historical account of the society, together with other intersting scientific and local information, a copy of which will be sent on application. It will greatly facilitate the arrangements of the committee if intending visitors will promptly advise the local secretaries, 32 University Street, Montreal, of their intention. All persons interested in literature and science may become associates for this meeting, and are cordially invited by the local committee to be present thereat.

— At a meeting of the Royal Meteorological Society, April 15, the following papers were read: — "Some Remarkable Features in the Winter of 1890–91," by Mr. F. J. Brodie, in which the author points out the peculiarities or special features of interest in the weather which prevailed over the British Isles during the past winter, and states that in addition to the prolonged frost, which lasted from the close of November to about Jan. 22, he finds that the barometric pressure for the whole winter was about a quarter of an inch above the average, and that when the wind was not absolutely calm there was an undue prevalence of breezes from some cold quarter; that the percentage of winds from the southward did not amount to one-half of the average, the number of foggy days in London was no less than twice the average, and the rainfall over the greater part of the British Isles was less than half the average; that "almost every element in the weather has been influenced to an abnormal degree by the remarkable prevalence of high barometrical pressure, and, if we were called upon to define the season 1890–91, we should have little hesitation in giving it the name of the 'anticyclonic' winter:" "The rainfall of February, 1891," by Mr. H. S. Wallis, in which the author states that this was one of the dryest months upon record, the mean rainfall over England, excluding the Lake District, being only .066 of an inch, or about one-fortieth of the average: "On the Variations of the Rainfall at Cherra Poonjee in the Khasi Hills, Assam," by Mr. H. F. Blanford, in which it is stated that Cherra Poonjee has long been notorious as having a heavier rainfall than any other known place on the globe, the mean annual fall being frequently given as about 600 inches. Mr. Blanford has made a critical examination of the various records of rainfall kept at this place, and has come to the conclusion that the above amount is too high, and that the average annual rainfall is probably only a little over 500 inches.

— The "Hopkins House of Commons," founded in 1884 under the impulse given by Professor Woodrow Wilson, and for some years a very popular organization of Johns Hopkins University, has been revived. A preliminary gathering was recently held, and it was determined to continue the society by obtaining as many new members as possible, and resuming regular sessions. Four meetings have now been held with an average attendance of about twenty-five, and it is hoped that the success of the organization is assured. Both graduates and undergraduates are eligible to membership, and the meetings are open to visitors. They are held in College Hall at 8 o'clock every Monday evening.

— An attempt is to be made to establish an engineering laboratory at Cambridge University (England) on the model of those at the Central Institution, Kensington, and at University College, Liverpool. The syndicate appointed to consider the question report that "the study of mechanics gains much in utility, and loses nothing in educational value, by being approached from the standpoint of the engineer." "This is an important admission," says *Engineering* of April 17, "as the unfortunate engineer has had to stand any quantity of abuse from physicists, such as Professor Lodge, because he does approach these matters from his own standpoint, and works with quantities he understands, and measures daily, such as weights rather than masses, and pounds per square inch instead of dynes per square centimetre. Professor Greenhill, who is an old Whitworth scholar, has, it is true, supported the engineers; but many physicists seem to consider him as more or less of a traitor who profanes their mysteries, in making them intelligible to the practically trained man. Apart from this, however, every one will agree with the dictum of the syndicate quoted above. The abstract ideas of the mathematician become concrete entities in the practice of the engineer, and both pure and applied physics should benefit from the establishment on a proper scale of an engineering laboratory at Cambridge. The principal difficulty is one of money. A sum of $100,000 is required; and, Cambridge not being a large business town like Liverpool, there is no one there able to imitate the generosity of Sir A. B. Walker at the

latter city. Still, among the alumni of the university there are so many wealthy men who should be proud to come to the assistance of their alma mater. The university have out of their present funds provided a suitable site, and have provided annual grants towards the payment of demonstrators and the current expenses of the department. More, however, they are unable to do, without outside assistance, which, it is to be hoped, will be promptly forthcoming."

— We learn from *Engineering* that the Kew Observatory are about to undertake the testing of photographic lenses, as they have long done that of telescopes, sextants, and surveying instruments, as well as watches and thermometers. Lenses up to four inches in diameter will be examined, and certificates awarded according to the performances of the glass. They will be tested in sets, the trials beginning about the 1st and 15th of each month. A lens may be entered either for a class A certificate or a class B one. In the first case, the fee for which is 10s. 6d., the test will comprise the determination of the length of equivalent focus; size of effective aperture with every stop in terms of focal length; angle of field of view and size of plate effectively illuminated; number of external reflecting surfaces; coincidence of visual and chemical foci; presence of flare spot; workmanship of surfaces, structure and degree of transparency of glass; centring in mount; defining power; relative quality of illumination in different parts of field, and amount of astigmatism or optical distortion. For a class B certificate, at a fee of 2s. 6d., the test will consist simply of the determination of the length of equivalent focus; size of effective aperture with largest stop; angle of field of view; size of plate effectively illuminated; and coincidence of visual and chemical foci. Further particulars of the arrangements can be obtained from the superintendent, Kew Observatory, Old Deer Park, Richmond. The fees charged are certainly very moderate for the work undertaken, and, from the character already earned by the officials of the Kew Observatory, there can be no doubt that this work will be thoroughly performed.

— In the course of excavations which are being carried out in the neighborhood of Vienna by the Academy of Sciences, a cavern was discovered on the slope of the mountain at Baden. A correspondent writes to the London *Times*, "It was plain, on a cursory inspection, that the cavern had been used not only in the middle ages, but long previously. At the time of the Roman occupation, Baden was the encampment of a veteran legion who were well acquainted with the good qualities of the waters. Decided remains of the foundations of a vestibule were found at the entrance of the cave. In a niche hewn out of the rock was an altar with the sacrificial stone table. In front of the cavern was a regularly constructed building, fully ten feet below the surface of the ground above, designed probably to conceal the cavern behind, which was most probably employed as a temple to Mithras. There were two stalls for horses, fragments of utensils, knives, flint arrow-heads, carved bones, mixed up with Roman coins, lamps, and stamped tiles."

— M. Henniqué, the director of the colonial section which formed such a pronounced feature of the Paris Exposition of 1889, has followed up his suggestion for a colonial exhibition at Paris in 1892 with characteristic energy; and there is now exery prospect of success, according to *Engineering* of April 17. The scheme, too, has immensely widened, and the society formed for its furtherance includes several members of the institute, many scientific men and political notabilities all working in earnest. The exhibition will be opened on May 1, 1892. It is to be held, of course, on the Champ de Mars; and the principal sections will be located in the Machinery Hall,— one of the glories of the 1889 exhibition, and at present used for popular gatherings on a large scale. Villages and encampments will be erected by natives of colonies, who will inhabit them, and in this way illustrate aboriginal life. The primary idea is to gather a thoroughly representative collection of the produce of the colonies of all nations, while the scientific and mechanical departments will indicate the methods adopted and possibility of adoption for development. It is not necessary to say that the popular attractions will be largely in evidence: Parisian management implies that. M. Lockroy, who had much to do with the 1889 exposition, being at the time minister of public instruction, is taking an active interest in the project. He has been elected president of the General Colonial Society, which is providing the necessary funds to the extent of $1,400,000. As soon as the Municipal Council grant the use of the Champ de Mars, the society will communicate with various nations, inviting co-operation. Special requests are to be made to Great Britain. Agents are at the same time to be sent to Africa, Asia, and America to arrange for groups of aboriginal tribes being sent to the exhibition. These will be changed from time to time, the exigencies of the ever-varying climate being the chief consideration in making the arrangements, so that denizens of the tropic as well as Arctic regions may be presented for the amusement of the patrons of the exhibition as well as for the study of ethnologists.

— At the meeting of the French Meteorological Society on March 3, a communication from M. Marès showed that the weather in Algeria had been as remarkable during the last winter as in Europe. The author stated, says *Nature*, that in many localities the excessive rainfall had prevented the sowing of seeds; and in the mountainous districts, where the sowing had taken place early, the seed had been swept away by the torrents. About the third week in January a heavy fall of snow lay on the Mitidja and the Sahel for two whole days. The writer states that for the last thirty-five years, although he had sometimes seen snow fall, it did not lie an instant on the ground. The effects had been disastrous to early crops and to many animals.

— A pleasant series of summer studies in botany was begun on April 23 by the Torrey Botanical Club and the College of Pharmacy of the City of New York, whose members have jointly arranged a course consisting of lectures and excursions extending throughout the summer. This course has been provided as a means of instruction for those business and professional men and women who desire to become practically acquainted with the chief principles of the science of botany and with local flora, but who are deprived of the ordinary means of study provided by schools and colleges. The course will consist of ten lectures by competent instructors, and ten excursions into the woods and fields by the lecturers and students. Professor Henry H. Rusby, Professor Henry Kraemer, and Professor Thomas Morong will be the lecturers.

— The executive committee of the last International Congress of Americanists, which was held in Paris from the 14th to the 20th of October last, decided that the next session of the congress should be held at such place as the Spanish Government should be pleased to indicate. The Spanish Government has now designated the Convent of Santa Maria de la Rabida, in the province of Huelva, as the place of the ninth session of the congress, which will commence on April 1, and end on Oct. 6, 1892. The Spanish Transatlantic Steamship Line offers free passage to two officially accredited delegates to the congress from each of the American republics, and half fare for all other duly accredited members who may desire to attend the congress at Santa Maria de la Rabida. The Spanish railways will likewise give delegates half fares. Any duly accredited person desiring to take part in the congress can apply for membership to the Spanish consulate here, and for a merely nominal fee will receive the proper credentials. The Convent of Santa Maria de la Rabida has been chosen by the Spanish Government because it is the place where Christopher Columbus received his first real encouragement in his plan to sail westward in an attempt to discover the Indies, and because it is near Palos, the port from which he sailed. The International Congress of Americanists has two aims,— to contribute to the progress of scientific studies, relative to the two Americas, especially in times previous to and immediately after Christopher Columbus, and to bring more closely together the persons engaged in such studies. A number of papers bearing upon matters in which the congress is interested will be read at the different sessions. Any paper requiring more than twenty minutes to read should be submitted in advance. The classes of questions on which papers are invited, and the various particular subjects under each class, are history, geography, archæology, anthropology, ethnography, language, and paleography.

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Attention is called to the "Wants" column. All are invited to use it in soliciting information or seeking new positions. The name and address of applicants should be given in full, so that answers will go direct to them. The "Exchange" column is likewise open.

TORNADOES: A STORY OF A LONG INHERITANCE.[1]

AFTER illustrating the effects of a number of tornadoes by lantern-slides, the lecturer defined a tornado as a violent whirling storm of small dimensions, rapid progression, and brief duration, and then considered the origin of its destructive winds. Following the generally accepted theory that the tornado whirl is developed in a convectional up-draught, it was shown, by analogy with the eddy of water running from a basin by a vent at the bottom, that if tornadoes did not whirl, they would lose most of their violence. But they all whirl, and nearly all in the same direction,— from right to left. The general possession of so well-marked a feature implies that it has been inherited from some antecedent condition, and it was therefore asked, where are tornadoes formed? The records of the Signal Service leave no room for doubt on this point: tornadoes are nearly always formed in the south-eastern quadrant of the large cyclonic storms or areas of low pressure, so characteristic of our daily weather-maps, and to whose passage across the country we owe most of our weather-changes. The cyclonic storms are vast whirls, their winds sweeping over great spirals as they gradually approach the centre of low pressure, but generally without destructive velocity, at least on land. The spirals of our cyclonic storms universally turn from right to left, and in this motion we undoubtedly have the reason for the general right-to-left whirling of the tornadoes; for, when a little whirl springs up in a great whirl, the turning of the two will be in the same direction. This may suffice to show why tornadoes turn; but it may next be asked why cyclonic storms turn. An answer will be found by examining the region of their occurrence. They are developed in the belt of prevailing westerly winds, which, taken as a whole, form a vast whirl from right to left around the north pole. When the cyclonic disturbance arises in this polar whirl, it must turn in the same direction as the polar whirl turns; that is, again from right to left. Tornadoes may therefore be said to have inherited their habit of turning from their grandparent, the general circulation of the winds of the northern hemisphere around the north pole.

But why do the winds whirl around in this way? Why not the other way? Why do they whirl at all? The sun warms the air at the equator, while it is cooled at the poles; the expanded equatorial air flows away aloft north and south, and for this reason we should expect to find caps of high pressure around the poles; but it must be remembered that the interchange between equator and poles was established in an atmosphere that was already rotating with the earth on which it lay. It possessed this rotation along with the oceans in the youth of the earth, when all was still glowing and molten with heat; and it was only later on, when the earth had cooled somewhat, that the sun began to determine our climatic zones, and start an atmospheric circulation: hence, as the equatorial overflow runs poleward, it approaches the axis about which it rotates. In accordance with the principle of the conservation of areas, it must take on a whirl around the pole from west to east, or, as the North Star would say, from right to left; and this whirl is so much faster than the rotation of the earth that the high pressure expected at the poles as a result of low temperature is reversed into low pressure, due to excessive centrifugal force. We thus learn that the prevailing winds whirl around the pole because they had a way of turning with the earth; that the cyclonic storms possess a spiral circulation from right to left because they are formed in a whirling atmosphere; and that the tornadoes whirl because they are generated in whirling cyclones.

But why does the earth rotate? On inspecting the planets of our system, we find that rotation appears to be a common characteristic of all. The sun, the moon, Mars, Jupiter, and Saturn all turn one way, these being the only bodies of our system whose direction of rotation has been surely observed. Moreover, they all turn on their axes in the same way as they revolve around the sun in their orbits. Saturn's rings turn in the same direction. Let us imagine what would happen if these rings were clotted somewhat at a certain point: the parts behind the clot would be hurried on, and thus gaining a greater orbital velocity, and consequently a greater centrifugal force, would tend to pass outside of the clot; the parts ahead of the clot would be retarded, and, thus losing some of the centrifugal force that they had before, would be drawn by the planet somewhat inside of the clot; the parts outside of the clot would be drawn inwards, and, thus approaching the centre of their orbital revolution, they would be accelerated, and would tend to run ahead of the clot; while the parts on the inside of the ring would be drawn outwards, and would lag behind the clot. All these parts thus conspire to set up a whirling around the clot as a centre, still maintaining their orbital motion around Saturn. As a result, when all the matter of the rings is concentrated at the clot, it will form a mass possessed of an axial rotation; and this rotation will be in the same direction as its orbital revolution. It has therefore been supposed that the planets once existed as rings around the sun; that the rings were not so evenly balanced as are those of Saturn, which survive as rings even to this day; and that the planetary rings gradually coalesced into rotating balls, and thus gained their community of rotation. And yet why should the planetary rings have all rotated the same way? For no reason, unless they inherited their movement from a common ancestor. This ancestor is thought to have been a vast nebula, whose inward spiral falling together gradually produced the rings, all turning one way around the great central mass, which later formed the sun. But why did the nebula turn around? Why did its parts not simply fall together in radial lines? Because the nebula came from chaos, and we must not imagine that chaos possessed so specialized an arrangement as no motion, or as precisely such motions as would neutralize all tendency to rotation while its parts were falling towards their common centre of gravity. Any thing but this in chaos. There must have been motions of all kinds, and, their resultant being unbalanced with respect to their centre, they necessarily developed a whirl as they coalesced into the primeval nebula; and this whirl, through rings, planets, winds, cyclones, and tornadoes, has never been lost.

It is not simply to the imagination that we must trust for our realization of these past stages of our history. The sun, being vastly larger than the earth, still retains a glowing temperature, such as the earth has long since lost. Saturn's rings, evenly balanced, marvellous examples of retarded development, illustrate a stage long out of date with the unevenly arranged rings of the planets. Most of the nebulæ of the distant sky are still in the chaotic stage; but the great nebula of Andromeda, when finely photographed, shows a series of incurving spirals, such as the North Star saw in our nebula so long ago. It is the inheritance of this early habit that makes our tornadoes whirl.

[1] Abstract of a lecture before the Johns Hopkins University Travellers' Club, Jan. 27, 1891, by Professor William Morris Davis of Harvard University.

LETTERS TO THE EDITOR.

**** Correspondents are requested to be as brief as possible. The writer's name is in all cases required as proof of good faith.*

The editor will be glad to publish any queries consonant with the character of the journal.

On request, twenty copies of the number containing his communication will be furnished free to any correspondent.

Flying-Machines.

FROM the age of mythology to the present time man has attempted to unravel the mysteries of flight, and to imitate the bird in its easy conquest of the ocean above us. The study of this question has been left to cranks or semi-intelligent dabblers in science. One of the latest instances was that of Mr. Lancaster, who was treated rather coolly at Buffalo at the meeting of the American Association in 1886. An offer of a hundred dollars was made for the display of a model that would meet his claims, but it is needless to add that the money did not change hands. Only last week, however, the usual rule was broken, as Professor Langley, who has a world-wide reputation as an eminent scientist, entered the lists as a champion of the idea that a flying-machine is practicable. We have been somewhat disappointed, however, on looking carefully into his scheme, and very much fear that he has only succeeded in more perfectly proving the impracticability of a direct imitation of the bird.

Professor Langley illustrates his views by drawing a picture of a man walking upon a series of cakes of ice, each one of which is so small that he would sink if he does not pass very quickly from one to the next. It is plain that if the man is given no assistance except a violent up-and-down movement of the arms, in imitation of a bird's wings, he would go down if he stood still; but suppose he had a pole resting on the bottom, it is easy to see that by exerting a slight pressure upon the pole he would be sustained by the cake of ice. We may well believe that the exertion required to support a part of one's weight in this manner would be very much less than that required to pass quickly from cake to cake. The same reasoning may be applied to a heavy bird standing upon ice: it may run from cake to cake with wings closed, or it may stand still and gently support a part of its weight by a use of its wings. In the latter case the exertion required would be much less than in the former. This idea of adaptability would seem to lie at the bottom of this whole subject.

If we had a balloon weighing two hundred pounds, and inflated, it would rise till it reached an equilibrium at two thousand feet, say. The exertion required to move it a limited distance in any direction, down or up, or sidewise, would be exactly the same. If, now, we empty the gas, we have changed all the conditions of flotation; and the covering, if compacted, at once falls with great speed to the earth. To keep up this ball of cloth by a blast of air would require the expenditure of a great deal of energy; and in like manner, if we undertook to transport it horizontally by a blast of air, and keep it from falling, it would require still more force: in fact, it is evident that a horizontal blast could not keep the body from falling, no matter what its force. On the other hand, we may support the ball by a cord, and then we can move it in any direction a short distance horizontally with the very slightest exertion.

Suppose the cloth of the balloon, instead of being compacted, could be stretched in a plane surface. The velocity of its fall would be much diminished; but to keep up a blast of air from outside to support this plane, or to move it horizontally, would require the expenditure of much more energy than before. Let us change the condition and apply the force directly to the plane, inclining it at the same time with the horizontal. It is evident that with an angle of 45° the resistance from the air would be large as compared with the skin-friction; but if the angle is made very small, say one degree, the total resistance at a much higher velocity would be the same as before. It would seem, however, that a plane under these conditions could be balanced only with the greatest difficulty; and, as Professor Langley has said, the steering and propelling apparatus have yet to be devised. It is easy to see that, after all, these three points are really the essentials; and if it can be shown that a plane, which is so very different from the bird in its form and adaptation to the air, is really essential to a solution of the problem, then we may say that it has been conclusively proved that a flying-machine pure and simple cannot be constructed. We may hope to vie with the bird, but we can never go beyond it in its general form, adaptability, and mode of action in flight.

Professor Langley thinks we can go fast much more easily than we can go slow. It is evident, however, that a bird does not support itself by going fast, for we have examples of its soaring and remaining stationary for quite a long time. It would seem, also, that the practical solution of the problem would be rendered much more difficult at great velocities. As a matter of fact, it would be much easier to go slow than fast; for the propeller, ballast, and other parts would have to be increased in such a ratio as the velocity increased, that the resistance of the air would become enormous, amounting, as it does, to forty pounds per square foot at a hundred miles per hour.

Professor Le Conte of San Francisco, in a recent number of the *Popular Science Monthly*, has summarized the arguments against flying-machines, and his position certainly seems impregnable. These arguments may be briefly paraphrased.

1. We can never construct a mode of utilizing fuel or a source of energy which shall equal the bird.

2 We can never build a machine which shall have such perfect adaptation to flight in all its parts as the bird has.

3. There is a limit of weight, probably fifty pounds, beyond which a bird cannot fly. Obviously a self-raising, self-supporting, and self-propelling flying-machine to carry a man is impossible.

H. A. HAZEN.

Washington, D.C., April 25.

Protection from Lightning.

I RECEIVED an invitation from you some time ago to criticise your theory of lightning, and since then I have been rolling the idea about in my mind to look at the lightning longitudinally, transversely, and askance. It was so novel that I did not quite get the idea at first reading, and it was so different from my already partly well defined views that I had to think about it, which accounts for my delay in replying. Some of your arguments are very strong; say, the observations of the stroke upon the steeple, etc., supposing that to be well authenticated. I don't believe I am well prepared to deny but you may have the solution, and I should be glad to know that you had.

Now, does not your theory imply that the first step in the transferrence of electric energy from an electrified cloud is to produce a stress in the ether between the cloud and another adjacent body, say the nearest, either cloud or earth; that the energy is therefore in the ether until the discharge takes place, and the discharge is the unloading the ether in a direction at right angles with the direction of the stress? The electricity, therefore, is not transferred from cloud to earth or from earth to cloud, but is only a kind of static collapse. Perhaps this does not quite represent your idea.

A. E. DOLBEAR.

College Hill, Mass., April 19.

BOOK-REVIEWS.

Outlines of Physiological Psychology. By GEORGE TRUMBULL LADD. NEW YORK, Scribner.

PROFESSOR LADD'S larger work, "The Elements of Physiological Psychology," is so well known to all students of this topic that this abridgment of the larger work hardly calls for extended notice. The scope of the work and the manner of treatment are essentially similar to those of the "Elements," and its handier form will undoubtedly make it a welcome volume to a large circle of students. It is distinctly the only work in English that pays due attention to the experimental work of foreign psychologists; and American readers, no matter what their points of agreement or disagreement with Professor Ladd's views may be, should be distinctly grateful for this useful service. One cannot repress the wish, however, that, while so much pains and ability were being exercised in compiling the volume, a little better perspective of view, a little more lucid and attractive form of statement, had

been added. These two defects will seriously hinder the service of the "Outlines," as they have of the "Elements." The facts which the beginner in psychology and the general reader alike need and desire, are the chief facts of modern scientific psychology in all its various departments. What is here termed "physiological psychology" is but a somewhat arbitrarily selected portion of that general body of knowledge. And within the field covered we find the same disproportion among the topics. The preliminary portion on the nervous system and the functions of the brain certainly occupies too much space for so elementary a work.

There is, too, a lack of vitality in certain portions of the work,— something that gives the student the impression that he is dealing with reports of papers and personal news, and not with facts and their interpretation. This defect is less marked in the newer work. It, too, has the advantage of benefiting by the more recent studies and the criticisms directed against the "Elements." While regretting these defects, we may none the less cordially recommend these volumes as an important and interesting means of approach to an important and interesting subject.

Animal Life and Intelligence. By C. LLOYD MORGAN, F.G.S. Boston, Ginn.

ONE of the dominant characteristics of modern English science is the attention devoted to the study of mental phenomena from a general biological point of view; the application of the comparative method, under the guidance of the principle of evolution, to the various activities contributing to and conditioning life, both bodily and mental. In so far as there exists a school of scientific psychologists in England, this is the common principle of their unity. A majority of the best known of modern English psychologists are men with a thorough and generally a professional biological training, who view the study of mind as a factor, and a most important and intricate one, in the general series of actions and re-actions of which life consists. It need hardly be said that in so doing they are continuing along the path so splendidly opened out by Darwin. It is to this school of thinkers that Mr. Morgan belongs; it is to this phase of psychology, or, if you prefer, biology, that the present work is devoted. The cardinal position of the work maintains the necessity of studying mind as a part of life, of studying it comparatively, of explaining, classifying, and studying mental phenomena by their purpose and significance in the natural, the biological world.

As the title implies, the work is divided into two portions, — the one setting forth the phenomena of animal life, the other dealing more particularly with those functions of life in which intelligence is involved; and it is extremely convenient to have so able a treatment of both topics between the same covers. For the student or the general reader whose aim it is to secure by the reading of a single book some insight into those central problems of biology, life, and intelligence, Mr. Morgan's is the book to be recommended. It is not an exhaustive treatment, but the selection of topics is according to the centres of most vital interest; and the treatment is always judicious, many-sided, interesting, and clear. After a general description of the qualities by which the organic is differentiated from the inorganic, and of the more important of the processes by which an individual life is maintained, runs the cycle of its life-history, and leaves its offspring to perpetuate the species, we are introduced to the kernel of modern biology, the relation of life to the environment. This portion of the work is considered under the heads of "Variation and Natural Selection," "Heredity and the Origin of Variations," and "Organic Evolution." While much of the contents of these chapters is mainly expository, and thus admits of originality or peculiarity mainly in the mode of treatment, the disputed points in modern biology are by no means avoided, and both sides of the case are always given. Chief among these disputed points is the one over which the biological camps are so sharply divided,— the inheritance of acquired characteristics. Mr. Morgan admirably states the importance of this issue, and returns to the problem again and again. He instructively as well as amusingly discusses the issue by considering whether "the hen produces the egg" or "the egg produces the hen." The Weismann view, which denies the inheritance of the influences of individual environment, would hold that "the egg produces the hen," and the parent egg is connected with the young egg, each developing to maturity under its own conditions; while, under the opposite view, "the hen produces the egg," that is, the egg is the offspring of the mature hen, modified since birth by a host of environmental accidents and conditions. Mr. Morgan's final position, reached by dint of much balancing and consideration, may be gathered from the following words: "Now, although I value highly Professor Weismann's luminous researches, and read with interest his ingenious speculations, I cannot but regard his doctrine of the continuity of germ-plasm as a distinctly retrograde step." So, too, in the mental world Mr. Morgan regards the hypothesis of the non-inheritance of acquired characteristics as untenable, though he fully admits the absence of crucial cases, and the possibility of interpretation of many facts from both points of view. In his final chapter he deduces from Professor Weismann's views the conclusion that education, "though it may raise the level of each generation, can have no cumulative effect;" that the diffusion of knowledge brings more grist to the mill but doesn't improve the mill, increases the store of food but not the powers of the digestive apparatus; and, in opposition to this view, it is held that the rise in the intellectual level of Englishmen of to-day, as compared with those of the days of the Tudors, has been in part due to the inheritance of individually acquired faculty."

Mr. Morgan's views on other of the factors and processes of organic evolution possess many points of interest and individuality, but it is impossible to do more than mention their existence in this connection. Some of the points which he emphasizes may be inferred from the following citation: "First, we should be careful not to use the phrase 'of advantage to the species' vaguely and indefinitely, but should in all cases endeavor clearly to indicate wherein lies the particular advantage, and how its possession enables the organism to escape elimination; next, we must remember that the advantage must be immediate and present, prospective advantage being, of course, inoperative; then we must endeavor to show that the advantage is really sufficient to decide the question of elimination or non-elimination; lastly, we must distinguish between indiscriminate and differential destruction, between mere numerical reduction by death or otherwise and selective elimination."

Entering now upon the more strictly psychological portion of the work, we meet first with a very clear and interesting account of the realm of sensation in the animal world. The keynote of the exposition is that the activity of a sense-organ must be accounted for by the utility of this mode of response to the environment in the struggle for existence. The fallacy of insisting upon an exact parallelism between human senses and those of animals is also strongly stated. The ground covered in the chapter upon "Mental Processes in Man" is familiar. It consists in the main of the description of the various processes involved in sensation, perception, inference, and the like. The two points most strongly insisted upon are that the relation to our environment involves the two factors of subject and object, of the mind that perceives and the things perceived; and that we must distinguish between the perceptual and the conceptual powers, the latter involving analysis and to some extent abstraction and consciousness. In attempting to study the resemblances and differences between human and animal intelligence, we must beware of endowing the animal with human points of view. The similarity of sense data is no guaranty for a similarity of mental perception and elaboration. In illustration of our tendency to neglect the ignorance of animals, there is cited Mr. Hamerton's story of the cow which was quieted by having the stuffed body of her dead calf to lick, and which, when accidentally tearing open the skin and seeing the hay inside, devoured the unexpected provender without showing the slightest surprise. But the surprise is only for us acquainted with anatomy: it is no incongruity to the cow, which indeed, having experience of "putting hay inside," not illogically expects to find hay there. We each construct our world, and how different the constructive powers in the two cases! In the description of instances of animal intelligence, which naturally find considerable place in the work, the analysis proceeds along a psychological basis, the degree of mental power being measured by

the degree of elaboration of the sense data. The same act may be accomplished by practical insight and by reasoned inference, but the grade of the processes be markedly different. The monkey that unscrews the hearth-brush from its handle doesn't discover the principle of the screw, but simply observes that certain actions lead to certain ends. This higher conceptual form of reason Mr. Morgan denies to animals; but, while "contending that intelligence is not reason, I [do not] wish in any way to disparage intelligence. Nine-tenths, at least, of the actions of average men are intelligent and not rational. Do we not all of us know hundreds of practical men who are in the highest degree intelligent, but in whom the rational analytic faculty is but little developed? Is it any injustice to the brutes to contend that their inferences are of the same order as those of these excellent practical folk?"

But intelligence is not the only factor in life, and indeed is always dependent upon some sensible, some emotional state; while its existence is evidenced only by some expression, some exercise of a motor activity. The origin and function of pleasure and pain, the relation between the emotions and their expression, the difficulty of appreciating how far and in what way animals are sensitive to pain (and many striking examples of apparent insensibility are given), the relative dignity and distribution of various typical emotions, to what extent the more intellectual and moral emotions may be present, — these are the points most fully considered. So, too, on the motor side are considered the various forms and grades of response to stimuli by which intelligence is manifested. What on the intellectual side is formulated as the distinction between intelligence and reason, on the motor side becomes instinct and rational habit. The far greater share which frequently repeated acts occupy in the lower animals, the earlier age at which in the lower animals these instincts emerge, the persistency with which they seek expression even under ridiculously inappropriate conditions, are some of the traits of importance in this regard. If there is one problem in comparative psychology upon which there are as many minds as there are men, it is that of instinct; and Mr. Morgan very naturally devotes some space in bringing out his own views and criticising those of others, more particularly in showing his agreement and points of dissension from Mr. Romanes. The final chapter of the volume deals with mental evolution as a whole, and with a philosophical expression of the relation of the subject to the object, of the act of intelligence to the objective source of sentience. Under the former head we have a clear and common-sense statement of the value and difficulties of appreciating the various and graded forms of mind, the continuous hierarchy of psychological stages. Under the latter Mr. Morgan states his monistic philosophy, his belief that there is one something showing two aspects, the physical and the psychological. The one deals with the physical forms of energy (kinesis); the forms exhibited by the other may then be called "metakinesis;" and, "according to the monistic hypothesis, kinesis and metakinesis are co-ordinate. The physiologist may explain all the activities of men and animals in terms of kinesis. The psychologist may explain all the thoughts and emotions of man in terms of metakinesis. They are studying the different phenomenal aspects of the same noumenal sequences."

When leaving the book, we do so with the conviction that it will take an important place in the literature of biology and psychology, by reason of the timeliness and good perspective of its chapters, by the clearness and many-sidedness of its expositions, by the suggestiveness and stimulus of its main position. Though containing much that is sure to require modification in the near future, and also considerable that is personal opinion rather than demonstrated truth, the volume may be cordially recommended as a most satisfactory way of approach to modern biological psychology.

IN the *New England Magazine* for May, 1891, appear, among other matter, "The Notes of Some New England Birds," by Simeon Pease Cheney; "The Alaskan Fur Trade," by Charles Hallock; and "The Oldest House in Washington" (illustrated), by Milton T. Adkins.

AMONG THE PUBLISHERS.

THE eleventh part of Edwards's "Butterflies of North America," just issued, is in every way equal to its predecessors. For the first time in this third series, each of the three large quarto plates, with the accompanying text, is given up to a single and relatively little known species of butterfly; two of them to species of *Satyrinæ*, a group which nowhere in the world has found so complete a treatment as in America, at the hands of our author. Excepting for the intermediate larval stages of *Satyrus meadii*, every single stage of the creature's life is represented, usually by more than a single figure, and all in that exquisite and finely exact style we have become accustomed to in this work, but which can never be too highly praised or too fully appreciated. Such illustrations lie at the very foundation of the exact knowledge of butterflies, and are the key to any proper understanding of their real relationships. The butterflies treated of are *Apatura flora*, *Satyrus meadii*, and *Chionobas chryxus*, all of them living from five hundred to a thousand or two miles from Mr. Edwards's home, where they were bred and studied. This shows at once the opportunities to be overtaken by any zealous student, and renders possible thorough acquaintance with our entire fauna. Mr. Edwards hints here and there at some of the difficulties of the work, to have overcome which, even partially, in the case of such distant and secluded insects as this *Satyrus* and this *Chionobas*, is a high merit indeed. *Apatura flora* is an inhabitant of our extreme southern border; *Satyrus meadii* lives at moderate altitudes in restricted localities in Colorado, New Mexico, Arizona, and Montana; and *Chionobas Chryxus* at higher elevations in the Rocky Mountains from Colorado to British America, and, if with Mr. Edwards we include *calais* in the species, also across the continent in the higher north. In all three species the caterpillars hibernate in early life; but the history of the species as given here presents nothing of unusual interest, and closely resembles that of their nearest allies. Eighty-one figures, most of them colored and many much magnified, are given on the three plates.

— Julius Bien & Co., New York City, announce that they will publish an "Atlas of the State of New York," provided sufficient encouragement is secured to warrant so costly an undertaking. Among the proposed features of the work are these: a general map of the State, exhibiting county and town boundaries, etc., railroads, canals, and all important cities and towns; temperature and rainfall maps; detailed maps of the counties, sixty in number, showing public roads, rivers, lakes, city and township boundaries, etc.; railroad lines and stations; street maps, on a large scale, of the principal cities; lines of original land patents; an alphabetical list of counties, townships, cities, and villages, with population from last census, and an enumeration of all post-offices.

— Professor F. M. Taylor of Michigan University will shortly publish in the "Proceedings of the American Academy of Political and Social Science" an article on "Natural Law," which deserves the attention of every one interested in political questions. The author joins issue with the current notions on that subject, and attempts to show how true the popular instinct is which prompts a man to defend his elementary rights, if need be, by force.

— There is announced to appear soon the first number of the *Pantobiblion*, a monthly international bibliographical review of the world's scientific literature. In the words of the prospectus, "The purpose of this new monthly is to help the literary men of any department concerned with the applied sciences generally, and particularly those devoted to any technical studies of any specialty, to be promptly, exactly, and completely informed of the correspondent branch of current scientific literature, and to keep pace with the times as regards the advancement of applied sciences, and especially of technics and engineering of every sort." The editor of the *Pantobiblion* is A. Kersha, civil engineer, Fontanka 64, St. Petersburg, Russia. American subscription orders may be addressed to Messrs. D. Appleton & Co., New York.

— The Johns Hopkins Press, Baltimore, announces for early publication "American Oyster-Culture with Special Reference to the Past and Future of the Oyster Interest of Maryland," a popular

summary of a scientific study, by William K. Brooks, Ph.D., professor of animal morphology in the Johns Hopkins University of Baltimore, and director of the Chesapeake Zoölogical Laboratory. The danger to our oyster interest, this great natural source of prosperity, is now generally admitted, and the methods of restoring and developing depleted beds which were advocated by Professor Brooks attract more and more attention. The author has been urged to prepare a new work on this subject, as his reports on the "Embryology of the Oyster" and on "The Oyster Industry of Maryland," which were published by the Johns Hopkins University in 1879 and 1884, are now out of print. In accordance with these requests, a complete revision of the former reports, with the addition of new matter, has been prepared. Dr. Brooks served as one of the Oyster Commission of the State of Maryland in the years 1883-84, and received from the Société d'Acclimatation of Paris, in 1880, its medal for his researches on the development of the oyster.

—Charles W. Dulles, M.D., retires this week from the editorship of the Philadelphia *Medical and Surgical Reporter*.

— From Thomas Whittaker, publisher, we have received "The Life Story of Our Earth" and "The Story of Early Man," by N. D'Anvers. These small volumes, of about one hundred and fifty pages each, belong to the Science Ladders Series,— a series of handy volumes intended to give young people some knowledge of the laws of nature and the progress of science. The books are written in language simple and easily understood, yet sufficiently accurate for the purpose in view; and the illustrations, though not as good as might be expected in books of the kind, are well chosen and plentiful.

— The March number of the new Zealand *Journal of Science*, which is the second number of the new issue, contains "The Forthcoming 'Flora' of New Zealand;" "Some Notes on the Occurrence of the Trap-door Spider at Lyttelton," by Robert M. Laing; "An Edible Fungus of New Zealand;" "New Caledonia Nickel Ores," by Thomas Moore; "On the Discovery of the Nickel-Iron Alloy Awaruite," by G. H. F. Ulrich; "On the History of the Kiwi," by T. J. Parker; "Botanical Notes," by D. Petrie; "Effects of Thunder on Milk;" "Escallonia macrantha and Bees;" "Fertilization of Native Flowers by Honey-bees;" "On the Preservation of Solution of Sulphuretted Hydrogen;" "The Anatomy of a New Zealand Earth-worm;" "Recent Papers on the Natural History of New Zealand;" "Occurrence of Glow-worms in a Deep Cave;" "Humble-bees;" "Australasian Association for the Advancement of Science;" "On the Preservation of the Native Fauna and Flora of New Zealand;" "The Bull-roarer of some Australian Tribes;" and "Linnean Society of New South Wales." The magazine is published by Matthews, Baxter, & Co., Dunedin, N. Z.

— Among the new books of Messrs. Kegan Paul, Trench, Trübner, & Co. are "The History of Canada," by William Kingsford, LL.D.; "Essays in Politics," wherein some of the political questions of the day are reviewed from a constitutional and historical standpoint, by C. B. Roylance Kent (the word "politics" is used by the author in the wide sense as including all those questions which affect the life of men as members of society; and he discusses some of the more important questions of modern politics from a constitutional and historical standpoint, and gives them their due place in the larger sphere or area of the political science to which they belong, grouping them under such general headings as "Questions of Sovereignty," "Federal Government," "Political Institutions of Switzerland," "Progress of the 'Masses,'" "Socialistic Legislation," "Science and Politics"); "Alone through Syria," by Ellen E. Miller; "Sketches from a Nile Steamer," by Mrs. Tirard; "Buried Cities and Bible Countries," by George St. Clair; "Pessimism: A History and a Criticism," by James Sully (second edition, with new preface); "Principles of Natural and Supernatural Morals," Vol. II. "Supernatural Morals," by the Rev. Henry Hughes; "Body, Parentage, and Character in History," notes on the Tudor period, by Furneaux Jordan; and "Simplified Grammar of the Telugu Language," by Henry Morris, with a map of India showing the Telugu country.

—In the May issue of the *Magazine of American History* we note, "A Great Public Character," in which the career of William H. Seward is traced. The second paper is "An Early West Pointer," by Hon. Charles Aldrich of Iowa. Then comes a treatise entitled "A Lost Chapter in American History," by Rev. Dr. George Patterson of Glasgow, in which the early attempts of the Portuguese to colonize the north-eastern coast of America are pointed out. "The First American Ship," a brief article by Professor G. Brown Goode of the Smithsonian Institute; "Some California Documents," from Charles Howard Shinn of San Francisco; and "General Varnum on a Constitution of Government, in 1787," from Gen. James M. Varnum of New York,— are valuable contributions.

— In the *Forum* for May are three scientific articles likely to interest our readers, in addition to many others, of course, which cannot be classed strictly as scientific. One of the three is on "The Transmission of Culture," by Professor Lester F. Ward; the second is on "Chemistry To-day, and its Problems," by Professor William Crookes; and the third is on "The Bertillon System of Identification," by Alphonse Bertillon. Professor Crookes does not approve of speaking of a new and an old chemistry, yet points out important advances.

— The May number of the *Educational Review* will have an interest to many because of its containing probably the last public expression of the late Dr. Howard Crosby,— a brief article on "Religion in the Common Schools;" and also an article on "My Pedagogic Autobiography," left unfinished by the late R. H. Quick, the author of "Educational Reformers." The other features of the number are articles on "The Limitations of State Universities," by Ex-President Horace Davis of the University of California, and on "The Teaching of History in the Elementary Schools," by Professor Salmon of Vassar; the last of Professor De Garmo's papers on Herbart; a letter from Friedrich Kirchner on educational matters in Prussia; the Bishop of Durham's recent address before the University Extension Society, on "Ideals;" and reviews by Professors Tracy Peck of Yale, A. B. Hart of Harvard, John Dewey of the University of Michigan, William North Rice of Wesleyan, Dr. J. H. Hyslop of Columbia, and Hon. D. H. Chamberlain.

— At the meeting of the Royal Geological Society, Feb. 20, the Bigsby medal was awarded to Dr. G. M. Dawson, F.G.S., of Ottawa. On handing the medal to Dr. Hicks, F.R.S., for transmission to the recipient, the president addressed him as follows: "In asking you to transmit the Bigsby medal to Dr. George M. Dawson, I request you to convey to him at the same time an assurance of how fully the council appreciates the value of his researches into the geological structure of Canada, and how cordially we hope that he may live long to prosecute the explorations which have shed so much lustre on the Geological Survey of his native country."

— The following is a complete list of the papers read at the April meeting of the National Academy of Sciences: "Further Studies on the Brain of Limulus Polyphemus," by A. S. Packard; "On Aerodromics," by S. P. Langley; "The Solar Corona, an Instance of the Newtonian Potential in the Case of Repulsion," by F. H. Bigelow; "Report on the Human Bones of the Hemenway Collection in the United States Army Medical Museum, prepared by Dr. Washington Matthews, U.S.A.," by J. S. Billings; "Application of Interference Methods to Spectroscopic Measurements," by A. A. Michelson; "The Corona from Photographs of the Eclipse of Jan. 1, 1889," by H. S. Pritchett; "Stellar Motion Problems," by Lewis Boss; "Effect of Pressure and Temperature on the Decomposition of Diazo-Compounds," and "Researches on the Double Halides," by Ira Remsen; "Allotropic Silver," and "Note on a Paper by M. G. Lippmann," by M. Carey Lea; "On the Yttrium Earths, and a Method of making Pure Yttrium," by H. A. Rowland; report of the Watson trustees, and presentation of the Watson Medal to Professor Arthur Auwers of Berlin; "On the Distribution of Colors in Certain North American Reptiles," by E. D. Cope; "The Taxonomy of the Apodal Fishes," by Theo. Gill; "Researches on the Embryology of Mollusks," by W. K. Brooks and E. G. Conklin.

INDUSTRIAL NOTES.

Electrical Instruments for Schools.

THE immense spread of electrical invention and application has required the services of many workers. It no longer suffices that these workers be taken from other callings, or thrust out untrained from our grammar-schools and academies. They must

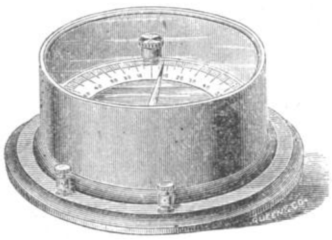

FIG. 1.

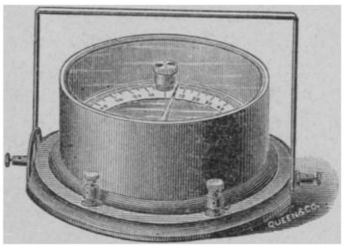

FIG. 2.

be skilled not only in the theory, but in the actual use of instruments and machines. But all cannot go to colleges and engineering schools to acquire this knowledge, and, even if they could, the colleges have not time to go back to elementary principles and teach the elementary use of instruments: hence a great part of this work must be left to the high-schools and other preparatory institutions throughout the country. Recognizing this fact, *a priori*, as well as in consequence of many and repeated demands from the schools themselves, Messrs. Queen & Co. have just designed and placed upon the market a complete series of electrical testing instruments for school use. Queen & Co.'s list of this

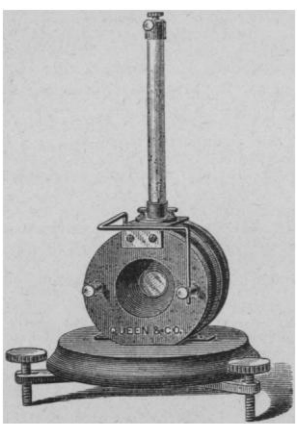

FIG. 3.

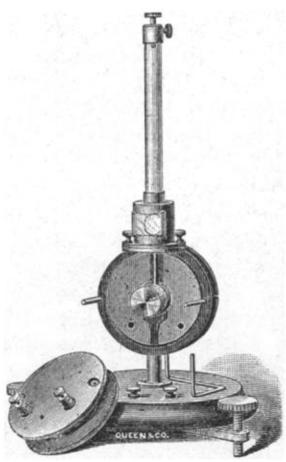

FIG. 4.

apparatus embraces all the instruments needed for a full year's course in laboratory electricity, and includes galvanometers of all kinds, resistance-boxes, Wheatstone bridges, voltmeters, etc. We note, from inspection of their catalogue, seven styles of winding of simple horizontal galvanometers; thus, the first one will measure currents from .01 to .5 of an ampère, and detect currents as small as .0025 of an ampère. This galvanometer is illustrated in Fig. 1. Fig. 2 shows a galvanometer which has, in addition to the usual winding of wire, a heavy copper strip allowing the measurement of currents up to 40 and 50 ampères. In addition to these simple galvanometers, are several styles of fibre-suspended galvanometers having an astatic system of needles and pointer moving over a finely graduated circle, so that deflections can be easily read. For still better work, the galvanometer shown in Fig. 3 has been specially designed. This galvanometer is built somewhat upon the plan of the well-known tripod galvanometer of Sir William Thomson, and is extremely sensitive. The mirror, which is very light, carries the magnetic system (several small bits of steel) on its back, and the whole is suspended by a very fine cocoon fibre about seven inches long. The coils are two in number, and may be connected in series or in parallel, as desired. They are easily movable. The magnetic system is enclosed by a thin, plane glass in front, and by another similar one behind. The latter is fixed in the end of a small tube which slips easily in the central axis of the rear coil, so that the air-space may thereby be easily increased or decreased at will. The galvanometer may in this way be made dead-beat or used undamped, as desired. By pushing the sliding tube until the air-space becomes small, readings may be taken with great rapidity, as the mirror will come to rest very quickly. The galvanometer may be made even more sensitive by the use of a control-magnet arranged to slide upon the tube containing the suspending fibre. This type of galvanometer is supplied wound to resistances of 100, 800, or 2,000 ohms, according to order.

Fig. 4 is an illustration of a galvanometer which will also be found useful. The coils, as in the last type mentioned, are two in

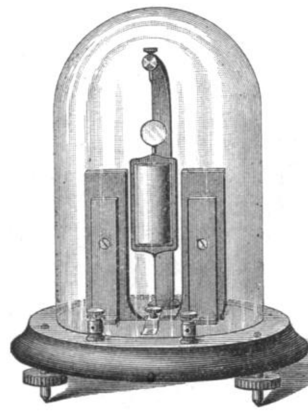

FIG. 5.

number, and may be coupled up in series or multiple, as desired. They are easily removable, and enclose a heavy block of copper fixed in a central fork. This copper block has a small cylinder bored partly through, in which hangs the bell-magnet making up the moving system. The magnet, with mirror attached, is suspended by a long and fine cocoon fibre, and, in consequence of being enclosed in the copper block, comes to rest very quickly after being deflected. In measuring and comparing condenser capacities, electro-motive forces, battery resistances, etc., by condenser methods, this galvanometer is very good, for, by simply lifting the copper block off the fork which supports it, the instrument is made ballistic. The coils are held in place by a special

FIG. 6.

device, so that they may be readily changed for coils of other resistances, thus adapting the instrument to almost all varieties of galvanometer work. This galvanometer, like the preceding, is furnished with any of several windings, or with several sets of coils for the same instrument, thus making it applicable to measurements of various kinds.

Another valuable type of reflecting galvanometer is the Deprez-D'Arsonval dead-beat galvanometer (Fig. 5), or, as it is commonly called, the D'Arsonval galvanometer.

This type of instrument has won favor with all, on account of its great delicacy of action, simplicity, and convenience. In a recent article in the *London Electrician*, Professor W. E. Ayrton gives it as his opinion, that, properly constructed, this type of galvanometer, is the most sensitive instrument known for the detection or measurement of electrical quantities. It is one of the finest of the "dead-beat" variety; and the needle, after being deflected, returns to its zero position immediately, and without the slightest oscillation, while it is so sensitive that it may easily be deflected through a considerable arc by simply touching the fingers to the two terminals of the instrument. The induction-currents produced by turning a coil of wire about a diameter so as to cut the earth's lines of force may also be rendered visible to an entire

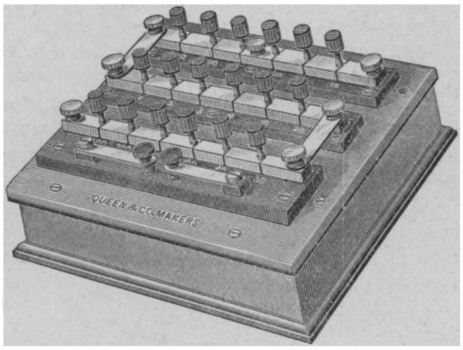

FIG. 7.

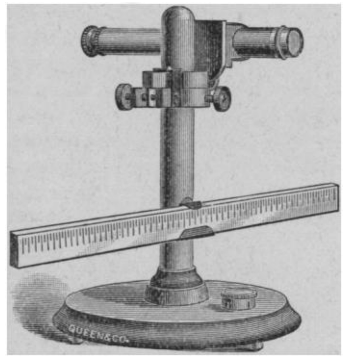

FIG. 8.

Publications received at Editor's Office, April 20-25.

BREWER, E. C. The Historic Note-Book: with an Appendix of Battles. Philadelphia, Lippincott. 997 p. 8°.
CONNECTICUT, Thirteenth Annual Report of the State Board of Health of the State of, for the Year ending Nov. 30, 1890. New Haven, State. 196 p 8°.
EMERY, F. P. Notes on English Literature. Boston, Ginn. 155 p. 12°. $1.10.
FEWKES, J. W., *ed.* A Journal of American Ethnology and Archæology. Vol I. Boston and New York, Houghton, Mifflin, & Co. 132 p. 8°. $2.
HARPER, W. R., and TOLMAN, H. C. Eight Books of Cæsar's Gallic War. New York, Cincinnati, and Chicago, American Book Co 502 p. 12°. $1.20
KANSAS Academy of Science, Transactions of the Twenty-second Meeting of the, 1889. Vol. XII. Part. I. Topeka, Kan. Pub. House. 189 p. 8°.
MASSACHUSETTS State Agricultural Experiment Station at Amherst, Eighth Annual Report of the Board of Control of the, 1890. Boston, State. 324 p. 8°.
NEW ZEALAND Journal of Science, The. Vol. I. No. 1. January, 1891. Dunedin, Matthews, Baxter, & Co. 48 p. 8°.
PACKARD, A. S. Insects Injurious to Forest and Shade Trees. (U. S. Entom.) Commis., Bull. No. 7. Washington, Government. 957 p. 8°.
POWERS, E. War and the Weather. Revised ed. Delavan, Wis., The Author. 202 p. 12°. $1.
RIBOT, Th. The Diseases of Personality. Chicago, Open Court Pub. Co. 157 p. 12°. 75 cents
ROYAL SOCIETY of Canada Hand-Book. Montreal Meeting, 1891. Montreal, Roy. Soc. Can. 140 p. 16°.
WRIGHT, L. Optical Projection: A Treatise on the Use of the Lantern, etc. London and New York, Longmans, Green, & Co. 426 p. 12°. $2.25.
ZOOLOGICAL Gardens and Aquaria for Boston: An Appeal. Boston, Bost. Soc. Nat. Hist. 47 p. 24°.

class. Another great advantage in instruments of this type is the fact that they are not affected by proximity to masses of iron or dynamo-machines.

Several styles of tangen galvanometers are also included in this list. Fig. 6 illustrates them. This instrument, properly adjusted, can be used as a standard instrument for laboratory work with entire satisfaction. The brass ring is thirteen inches and a half in diameter, and the groove in which the wire is wound is carefully turned so as to be of perfectly rectangular cross-section, thus allowing the constant of the instrument to be carefully calculated, and compared with the constant as obtained by other methods. The whole instrument has been specially designed to meet the requirements of teachers in laboratory practice who desire to make students entirely familiar with all the adjustments of the standard galvanometer before putting a high-grade instrument in their hands. The compass-box, five inches in diameter, is so held in position that it may be raised or lowered, rotated on its vertical axis, shifted out of the plane of the coil, etc., thus enabling the student to acquire proficiency with the instrument, and to meet all cases of derangement possible.

The dial is graduated to single degrees, while a mirror under it allows readings to be made without error of parallax. The needle is suspended by a very light cocoon fibre. The whole instrument can be turned about its vertical axis, and a quadrant graduated to degrees upon the base allows the amount of rotation to be accurately measured, and the laws of the sine galvanometer investigated.

Of resistance-boxes, this list offers a variety. Fig. 7 is a combination Wheatstone bridge and resistance-box having twelve coils, and, in addition, bridge-coils of 10, 100, and 1,000 ohms on a side, thus giving a total range of measurement of from .01 of an ohm to 111,000 ohms. Separate keys, properly connected, for battery and galvanometer, are mounted on the same top with the set.

Queen's "New Model" reading telescope (Fig. 8) will please many who have long been seeking something of the kind, reliable, and at the same time reasonable in price.

PROTECTION FROM LIGHTNING.

"The main point which I would urge upon your consideration is that by giving the electrical energy something which experience shows it will readily dissipate, that is, a conductor of varying resistance and small size, we can but mitigate the effects of lightning-discharges, so long as the conservation of energy holds true. I will only repeat that I have so far found no case on record where the dissipation of such a conductor has failed to protect the building under the conditions already explained."—*From paper read before the American Institute of Electrical Engineers, April* 21.

PROSPECTUS.

47 LAFAYETTE PLACE, NEW YORK, March 9, 1891.

It is proposed by the owners of letters patent dated Dec. 16, 1890, on an improved method for protecting buildings from lightning, etc., to organize a company for the handling of said patent and all improvements; and subscriptions are requested on the following terms and conditions:—

1. A company is to be organized with a capitalization of $10,000, in 1,000 shares of $10 each, fully paid in at par, the company to be organized in such State as the subscribers may determine by vote when all shares have been subscribed for, and with a charter to contain a provision that the amount of capitalization shall never be increased.

2. This $10,000 is to be used as working capital; and the object of the company wil simply be to place licenses with responsible persons, corporations, or sub-companies, al such rates of royalty as may be agreed upon by a majority vote.

3. In lieu of any stock or cash payment to the inventor for his patent, the inventor will give said company the exclusive control of his said inventions in consideration of the payment to him by said company of one-third of the gross royalty receipts.

The officers of the company shall be elected by a majority vote of the stockholders without reserve. No stock shall be given to anybody for services or any thing else except actual cash payment at par into the treasury.

No subscriptions will be binding until the full number of 1,000 shares has been subscribed for.

Subscriptions are solicited in amounts from five shares upwards. The list opens with subscriptions for **one hundred and five** shares.

The names of those who have subscribed will be sent to any intending subscriber upon application.

N. D. C. HODGES.

BUSINESS OPPORTUNITY.

There is a good chance for the right man as Manager of the

LIGHTNING PROTECTION COMPANY,

which is being formed to operate under broad patents. The new method will certainly revolutionize the whole system of protecting property from lightning.

Those interested should send for report of the meeting of the American Institute of Electrical Engineers, held April 21.

Local companies are already forming to operate under licenses from the parent company, and we should be glad to hear from any who would care to consider entering this new field.

Correspondence is solicited with those desiring further information.

N. D. C. HODGES, 47 Lafayette Pl., N.Y